Soil Lichens of the Loess Hills Prairies in Iowa

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Soil Lichens of the Loess Hills Prairies in Iowa

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and
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Soil lichens occupy a unique niche in drier grasslands. They are usually inconspicuous, but they flourish in the Loess Hills prairies where the vegetation cover is sparse and the exposed soil between the dominant bunch grasses is available for colonization. Of 34 lichen species reported to occur on soils in Iowa, 11 species are well developed in the prairies of the steep, dry, loess slopes. The same species are abundant on upper slopes and gravelly ridges in remnant prairies throughout western and northwestern Iowa. The thalli of these lichens are well adapted for xeric conditions. They are typically small and compact, squamulose to subfleotic, and of gelatinous to leathery consistency. Most are densely rhizinate, enabling them to persist on a substrate highly prone to erosion.

INDEX DESCRIPTORS: soil lichens, loess prairies, Bacidia sp., Caloplaca sp., Campariariella sp., Cladonia spp., Collema sp., Dermatocarpon sp., Diplachistis sp., Endocarpon sp., Heppia sp., Leidus sp., Thrombium sp.

Soil lichens occupy a unique niche in the grassland ecosystem and are an intriguing, but much overlooked, component of the state's lichen flora. They represent a significant gap in our understanding of Iowa's lichens because of their occurrence in a habitat (i.e., grasslands) seldom treated by lichenologists and other cryptogamic botanists in floristic surveys. To date, 264 species of lichens have been reported from Iowa, 34 of which occur on soil (Malone & Tiffany, 1978). Within this terricolous group, we have identified a distinctive complement of 13 species that are indigenous to native prairies of western Iowa.

Collections were made at the Iowa prairie sites listed in Table 1 (Figure 1) from 1978 through 1983, with intensive field work in the Loess Hills prairies from 1981 to 1983. Specimens have been deposited in the mycological section of the Iowa State University herbarium.

Locations and legal descriptions for the prairie collection sites are given in Table 1. The 13 lichen species identified are listed in Table 2 along with the sites where they occurred. Taxonomic treatments used in making the identifications included Fink (1910, 1935), Degelius (1954), Duncan (1970), Taylor (1968 a, b), Thomson (1967), Weber (1963), and Wetmore (1967). Nomenclature follows the checklist of the lichens of North America by Hale and Culberson (1970).

We have grouped the species of soil lichens collected from Loess Hills prairies and other Iowa prairie sites on the basis of frequency of occurrence (Table 2). Group I contains the most common and characteristic species of the Loess Hills prairies, Collema tenax, Dermatocarpon lachneum, Endocarpon pusillum and Leidus decipiens. These four widely distributed species can be found in exposed grassland sites in western North America and in arid regions throughout the world. They were found in abundance at every Loess Hills prairie site that we sampled.

Species in Group II also have broad geographic ranges but differ from group I species in that they occurred less frequently and less abundantly. Bacidia bagliettoana, Caloplaca stillicidiorum, Campariariella viellina, Cladonia apodocarpa, Cladonia cariosa, Heppia lutosa, and Thrombium pygium in this category occur in the Loess Hills prairies.

Squamarina lentiger, Group III, is designated separately because it is considered to be a western species. Fink (1935) reported it from Nevada, Colorado, Nebraska, and Montana; Wetmore (1967) collected it from the Black Hills in South Dakota. We found it only on gravel ridges at Cayler Prairie and Freda Haflner Kettlehole, both

pusillum especially when dry. Contrast to the colorless, nonseptate ascospores are borne in each clavate ascus. The ostioles protrude slightly above the surface and appear brown coloration and terriciolous habit make cial ostioles in the western prairie soil lichen group, Endocarpon genetically based morphological differences.

Table 2. Soil lichen collecting stations and their locations in Iowa.

<table>
<thead>
<tr>
<th>SITE #</th>
<th>SITE NAME</th>
<th>LEGAL DESCRIPTION</th>
<th>COUNTY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOESS HILLS PRAIRIES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Banks Tract</td>
<td>Sec. 20, T91N, R49W</td>
<td>Plymouth</td>
</tr>
<tr>
<td>2</td>
<td>Dahm Tract</td>
<td>W 1/2 Sec. 18, T85N, R44W</td>
<td>Monona</td>
</tr>
<tr>
<td>3</td>
<td>Gleason-Hubel Wildlife Area</td>
<td>Sec. 30 &amp; 31, T81N, R45W</td>
<td>Harrison</td>
</tr>
<tr>
<td>4</td>
<td>Loess Hills Wildlife Area</td>
<td>NW 1/4 Sec. 9 and</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Raglan Tract</td>
<td>W 1/2 Sec. 21, T84N, R44W</td>
<td>Monona</td>
</tr>
<tr>
<td>6</td>
<td>Stone State Park</td>
<td>E 1/2 Sec. 21, T80N, R44W</td>
<td>Harrison</td>
</tr>
<tr>
<td>7</td>
<td>Waukon County State Park</td>
<td>E 1/2 Sec. 31, T67N, R42W</td>
<td>Fremont</td>
</tr>
<tr>
<td></td>
<td>WESTERN DES MOINES LOBE PRAIRIES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Anderson Prairie</td>
<td>NW 1/4 Sec. 33, T100N, R34W</td>
<td>Emmet</td>
</tr>
<tr>
<td>9</td>
<td>Cayler Prairie</td>
<td>NW 1/4 Sec. 17, T99N, R37W</td>
<td>Dickinson</td>
</tr>
<tr>
<td>10</td>
<td>Freda Haffner Kettlehole</td>
<td>SW 1/4 Sec. 33, T99N, R37W</td>
<td>Dickinson</td>
</tr>
<tr>
<td></td>
<td>HILLSIDE “GOAT” PRAIRIE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Turkey River Mounds</td>
<td>NE 1/4 Sec. 11, T91N, R2W</td>
<td>Clayton</td>
</tr>
<tr>
<td></td>
<td>MISSOURI RIVER FLOODPLAIN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Tyson Bend Wildlife Area</td>
<td>NW 1/4 Sec. 29, T79N, R45W</td>
<td>Harrison</td>
</tr>
</tbody>
</table>

Table 2. Soil lichen species of some Iowa prairies and their collection sites.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>COLLECTION SITES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I</strong></td>
<td></td>
</tr>
<tr>
<td>Collema tenax</td>
<td>1,2,3,4,5,6,7,9,10</td>
</tr>
<tr>
<td>Dermatocarpon lachneum</td>
<td>1,2,3,4,5,6,7,9,10,12</td>
</tr>
<tr>
<td>Endocarpon pusillum</td>
<td>1,2,3,4,5,6,7,9,10,11,12</td>
</tr>
<tr>
<td>Lecidea decipiens</td>
<td>1,2,3,4,5,6,7,10</td>
</tr>
<tr>
<td><strong>Group II</strong></td>
<td></td>
</tr>
<tr>
<td>Bacidia baglietianiana</td>
<td>3,4,7,9,10</td>
</tr>
<tr>
<td>Caloplaca stilllicidiorum</td>
<td>1,3,5,6,9,10</td>
</tr>
<tr>
<td>Candelariella vitellina</td>
<td>5,6,9</td>
</tr>
<tr>
<td>Cladonia apodacarpa</td>
<td>1,7,8,9,10</td>
</tr>
<tr>
<td>Cladonia carrisi</td>
<td>3</td>
</tr>
<tr>
<td>Diplachites scoposus</td>
<td>9,10</td>
</tr>
<tr>
<td>Hippiut lutosus</td>
<td>7,10</td>
</tr>
<tr>
<td>Thrombium epigaeum</td>
<td>2,3,9,10</td>
</tr>
<tr>
<td><strong>Group III</strong></td>
<td></td>
</tr>
<tr>
<td>Squamarina lentigera</td>
<td>9,10</td>
</tr>
</tbody>
</table>

Lecidea decipiens Ehrl.

The small squamules of this species are a distinctive bright salmon-pink with white margins. Although this species is widespread, specimens with apothecia are infrequent. The strongly convoluted black apothecia are borne at the margins of the thallus. The ascospores are simple, ellipsoidal, hyaline, 10-16×5-7 μm, 8 per ascus.

Group II

Bacidia baglietianiana (Mass. & DeNor.) Jatta

The thallus is without obvious differentiation into cortical or medullary layers but forms a gray-green, warty, granulose crust on soil or growing over mosses. The small sessile apothecia are black, becoming convex in age. The clavate asci bear 8 acicula (needle-like) ascospores that are several-septate, although the septations are often faint and scarcely visible.

Candelariella vitellina (Ehrl.) Mull. Arg.

The thallus is composed of diminutive, crenately lobed squamules without a strongly delineated upper cortex or medullary layer, bright lemon-yellow to greenish-yellow, attached to the substrate by white rhizines. The apothecia, also yellow, are small, 0.3-1.0 mm in diameter, sessile, with a flat disc and thalline exciple. Clavate asci each contain from 12 to 32 hyaline, ellipsoidal, mostly 1-septate, 8-18×4-6 um ascospores.

Caloplaca stilllicidiorum (Vahl) Lyne

The thin gray to white thallus is granulose, often disappearing with only the conspicuous brightly colored, yellow to orange apothecia remaining. The apothecia are small, sessile, with a flat to convex disc and sometimes with white pruinose margins. Ascospores are polariologrular, hyaline, ellipsoidal, 10-15×7-9 um, 8 per ascus. This species is found at the soil surface on plant detritus such as the well-weathered rhizomes and culms of prairie grasses.

Specimens were assigned to this taxon primarily because all our collections were found on weathered plant detritus, a substrate recognized by Wetmore (1967) only for C. stilllicidiorum. This may be somewhat arbitrary because there are 3 other species, C. pyracea, C. gallicus, and C. cirrata that appear to closely overlap C. stilllicidiorum in terms of thallus morphology, apothecia and spore characters, and to be virtually indistinguishable except for slight differences in substrate affinity. The possibility exists that these are not distinct species but, rather, a continuum of ecotypes. It is hoped that future taxonomic revisions in the genus Caloplaca will address this question and clarify the relationships among these taxa.
Squamarina septate transversely, shallowly lobed margins, and often form dense patches. The contrast-
center densely pruinose with age; the surface at the center green or darker, closely adnate to the substrate, with thickened,
pits. The ascospores are nonseptate, ellipsoid, 15-25 per 
Chemical tests: K dark brown apothecia 
depth concave with only a thin exciple, 
other species of Cryptothallus. 
8-10 um, typically 8 per ascus. 
Tests: K+ yellow, KC-, P+ red (Wetmore, 1967) 

Cladonia apodocarpa Robb. 
The vegetative thallus in this species consists entirely of the persist-
tent primary squamules. Margins of the thallus have upturned lobes 
showing undersurface that contrasts sharply with the 
dull ashy-green upper surface. Pycnidia appear as small black dots on 
the surface of the thallus. We did not observe fruiting bodies in any of 
our collections, and fertile specimens are rare. Apothecia, when 
present, are reported to be dark brown and attached directly to the 
primary thallus. 

Chemical tests: K+ yellow, KC-, P+ red (Wetmore, 1967) 

Cladonia cariosa (Ach.) Spreng. f. squamulosa Mull. 

Lobes of the persistent primary thallus are often finely divided to 
branching, ascendant, green on the upper surface, white beneath. The 
dark brown apothecia are borne in clusters at the tips of the cylindrical 
branching podetia. Surface of the podetia is usually deeply fissured 
and rough textured. Pycnidia may occur on both primary squamules 
and podetia. 

Chemical tests: K+ yellow, KC-, P- (Wetmore, 1967). 

Diplochistes scroopus (Schreb.) Norm. 

In this species, the thallus forms a continuous minutely granulose 
to warty, greenish or ashy-gray crust, with small black, deeply 
concave, almost crater-like apothecia, 0.3-0.5 mm across, sunken 
into the thallus surface. At maturity the asc contain 4-6 large dark 
brown, muriform ascospores, 1-2 septate longitudinally and 3-6 
septate transversely, 26-30 × 10-12 um. 

Hypa latous (Ach.) Nyl. 
The large, flat, round thallus squamules, 0.5-1.0 cm, are olive-
green or darker, closely adnate to the substrate, with thickened, 
shallowly lobed margins, and often form dense patches. The contrast-
ning brick-red apothecia are deeply concave with only a thin exciple, 
giving the thallus an appearance of being pockmarked by rusty brown 
pits. The ascospores are nonseptate, ellipsoid, 15-25 × 5-10 um, 8 
per ascus. The phycobiont is a cyanobacterium. 

Thrombium eigeum (Pers.) Wallr. 
The thallus is thin, finely granulose, grayish or bluish-green, 
partly immersed within the substrate and lacking internal differentiation. 
The fruiting bodies are perithecia, with the ostioles appearing as 
raised black dots on the surface of the thallus. Eight hyaline, 
nonseptate, ellipsoid ascospores are produced in each ascus. 

Group III 

Squamarina lentigera (G. Web.) Poelt 
The thick, foliose thallus is pale green-gray to cream, becoming 
densely pruinose with age; the surface at the center is broken and 
chinky-aerolate while the margins are flattened and distinctly lobed. 
Buff to tan apothecia, 0.5-2.0 mm in diameter, are clustered over 
the center of the thallus. The apothecia are flat, sessile, with a thin 
thalline exciple. The ascospores are simple, hyaline, ellipsoid, 10-
12 × 4-6 um, typically 8 per ascus. 

DISCUSSION 

Soil lichens, associated with other prairie elements, are common in 
the Loess Hills prairies of western Iowa where the sward-forming 
dominant grasses give way to a more bunched growth form. This 
difference in growth habit reflects the reduction in average annual 
rainfall as one moves from east to west across the state. At Dubuque in 
eastern Iowa, yearly precipitation averages 34 inches and in Sioux City 
on the western Iowa border, only 26 inches. Consequently, the 
vegetation cover in western Iowa prairie grasslands is more sparse and 
has more exposed soil available for colonization. 

A low moisture-holding capacity of the loess substrate and the 
rugged relief accentuate the drying conditions imposed by lower 
rainfall. Although the loess province extends from the Missouri River 
east to the Cary Lobe (Oschwald et al. 1965), the most spectacular 
sequences of dry prairie are found in the narrow corridor of bluffs 
facing the Missouri River (Prior, 1976; Prior et al., this issue). Here, on 
sheltered south and west exposures subjected to drying by 
westerly winds, the most xerophytic conditions in the state are found 
(Shimek, 1910). Lichen colonies, apparently well suited to this dry 
environment, form extensive crusts up to several square meters in 
diameter. 

Prairie remnants east of the Cary Lobe also may have soil lichen 
floras like those of the Loess Hills prairies, but only to a limited extent. 
They are restricted to areas where soil factors create highly 
localized drought conditions, such as in the goat prairies of the 
Mississippi River bluffs at Turkey River Mounds (Table 1). The sand 
prairies, such as at the Big Sand Mounds near Muscatine, support a 
well developed, diverse lichen flora (Schulten, J., 1983, pers. com-
mun.) but it is a different lichen flora than that of the Loess Hills 
prairies. 

The soil lichen species consistently present in the Loess Hills 
prairies and on the gravelly morainal ridges of prairies in Emmet and 
Dickinson Counties in northwest Iowa are the same species reported as 
components of the cryptogamic earth soils from the grasslands of 
semi-arid regions of the western United States (Anderson and Rushforth, 1977). 

Loman (1964), in his study on the distribution of five lichen 
communities in the Canadian Prairie Provinces and adjacent parts of 
the Great Plains, considers the group of species which we have found 
to be common in the Loess Hills prairies as part of the Permatozoid 
phyllophorae association. In a transect along the 43rd parallel from 
Madison, Wisconsin to Douglas, Wyoming, he found soil lichens of 
this association on bare, mostly calcareous soils in sites with a 
vegetation cover of less than 50%. 

These same squamulose lichens, often the same species of 
Dermatocarpon, Poria (Lecideae), and Hypa, have been reported from soils 
of desert regions throughout the world (Rogers, 1977). In these arid 
habitats, the crusts of crustose, squamulose, and less commonly, 
foliose lichens can cover the soil surface and have an important 
influence on soil stability, water relationships, and fertility (Rogers, 1977). 

The commonest species of Loess Hills prairie soil lichens, group I, 
share several characteristics. Most are densely rhizinate, enabling 
them to persist on a substrate prone to erosion. Malone (1977) 
examined the rhizine systems of thalli of Endocarpon puillum growing 
around the bases of prairie grasses from several sites in Loess Hills 
prairies. Apparently separate thalli were actually interconnected by 
a network of rhizines, interpreted as rhizomorphs by Malone. Chains 
of thalli and connecting lateral rhizomorphs nearly 5 cm long and 
vertical rhizomorphs nearly 2 cm long were dissected from the soil. 
Predominately squamulose to subfoliose in growth habit, lichens of 
this group have individual thalli that are small and compact. In 
species of this form, surface to volume ratio is reduced and the 
gelatinous to leathery consistency of the thallus imparts an ability to 
withstand long periods of desiccation without damage. Reproductive 
structures such as apothecia have gelatinizing paraphyses that extend 
over the spore-containing asci. Perithecia have the added protection of 
being fully immersed within the lichen thallus. 

Of the 13 terricolous species that we have identified from western 
Iowa prairies, two, Collema tenax and Hypa latous, have blue-green 
phycobionts. Rogers, et al. (1966) demonstrated N-fixation by a 
species of Collema, a lichen with a heterocystous blue-green phyco-
biont. Snyder and Wulfstein (1973), examining the role of desert 
cryptogams in nitrogen fixation, demonstrated that Dermatocarpon 
lachenum thalli associated with Nostoc sp. could fix nitrogen. They also 
demonstrated N-fixation by the Nostoc blue-green phycobiont of 
Collema. Shields (1957) and Shields et al. (1957) reported the nitrogen
content of soils with a lichen crust to be higher than that of soils without such lichens. Nitrogen fixation by these soil crust lichens in arid and semi-arid ecosystems could supplement the nitrogen contribution from scattered nodulated legumes.

In summary, Loess Hills prairies of western Iowa have a well-developed soil lichen flora. It includes some of the same cosmopolitan species present on the soils of more arid grasslands. The western Iowa prairies are transitional to two major grassland formations, the Mesic Tall Grass Prairie to the east and the drier Mixed Grass Prairie to the west. The presence in the loess prairies of the same lichen species which can be found in greater abundance on the western semi-arid grasslands in association with prairie plants of decidedly eastern affinity, gives evidence of overlapping phytogeographic boundaries.

ACKNOWLEDGMENTS

The generous assistance of Dr. George Knaphus, who contributed his field expertise and served as photographer on many field trips, is gratefully acknowledged.

REFERENCES


Key to soil lichens of western Iowa prairies

1. Thallus foliose, squamulose or fruticose

2. Thallus granulose-crustose or disappearing entirely with only the bright yellow to orange apothecia plainly visible

3. Thallus algae blue-green (a cyanobacterium)

4. Thallus algae green

5. Thallus foliose, black, gelatinous, lacking internal differentiation and having radiating plicate lobes; ascospores longitudinally and transversely septe.

6. Collema tenax

7. Thallus of thick, flat, olive-green to brown squamules with entire to wavy margins, paraplectenchymatous throughout; ascospores nonseptate

8. Thallus composed of distinct squamules, often upright or with upturned margins

9. Thallus foliose, at least at the margins which are deeply lobed, becoming chinky-subaerolate and pruinose in the center with age

10. Squamarina lentigera

11. Thallus of numerous green to gray-green squamules with upturned margins and white to cream-colored undersurface, often in densely crowded masses

12. 6 genus Cladonia

13. Thallus of pink, yellow or brown squamules

14. Podetia and apothecia lacking, thallus consisting entirely of vegetative squamules

15. Cladonia apodocarpa

16. Podetia and apothecia present, brown apothecia apical on branched podetia

17. Cladoma cariosa

18. Squamules lemon yellow, small, crenately lobed, with yellow apothecia

19. Candelariella vitellina

20. Squamules pink or brown to tan in color

21. Squamules bright salmon pink with white lower surface; apothecia, when present, black, borne on the margins of the thallus

22. Leucidea decipiens

23. Squamules tan to red-brown; fruiting bodies perithecia, the ostioles erupting through the thallus surface as black dots

24. Dermatocarpon lachnum

25. Thallus a gray green warty-granulose crust

26. Thallus a thin white to gray granular crust, often disappearing, only the conspicuous bright yellow-orange apothecia visible, growing on plant detritus at the soil surface

27. Caloplaea stilliscidoria

28. Ascosporum muriform, dark brown, 1-2 ascus

29. Diploschistes sorosporus

30. Ascosporum hyaline, one celled or with faint transverse septations

31. Spores never seporate, ellipsoid, fruiting body a peritheciun

32. Aspergillium epigaeum

33. Spores acicular, faintly transversely seporate, fruiting body a small black convex apothecium

34. Barcidia bagliettoana